Humboldt Squid (*Dosidicus gigas*) in the Monterey Bay National Marine Sanctuary: Electronic Tagging Reveals Behavior and Habitat Use

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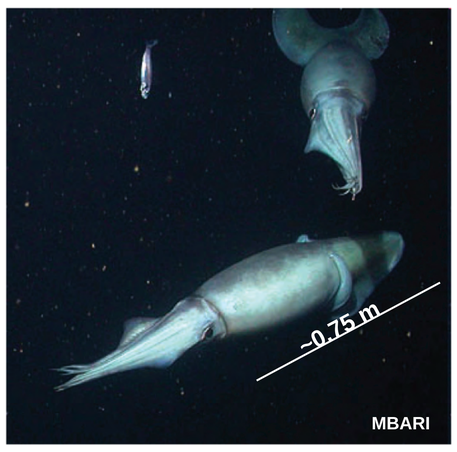
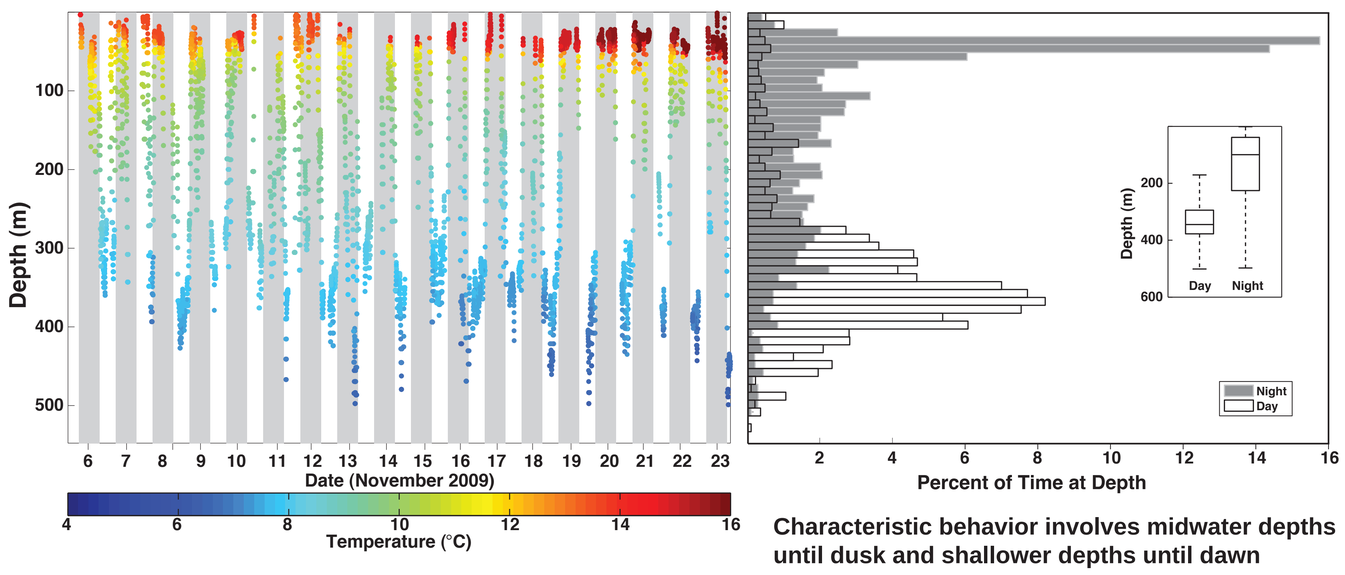


Humboldt squid have expanded their northern habitat range from Mexico to Alaska. They have been present in Monterey Bay since 1997 (Zeidberg & Robison, 2007), although their abundance fluctuates annually and interannually.

Humboldt squid feed mainly on myctophids and other mesopelagic micronekton. In California, they supplement their diet with Pacific hake, pelagic rockfish, and market squid--all ecologically and economically important species (Field *et al*. 2007).

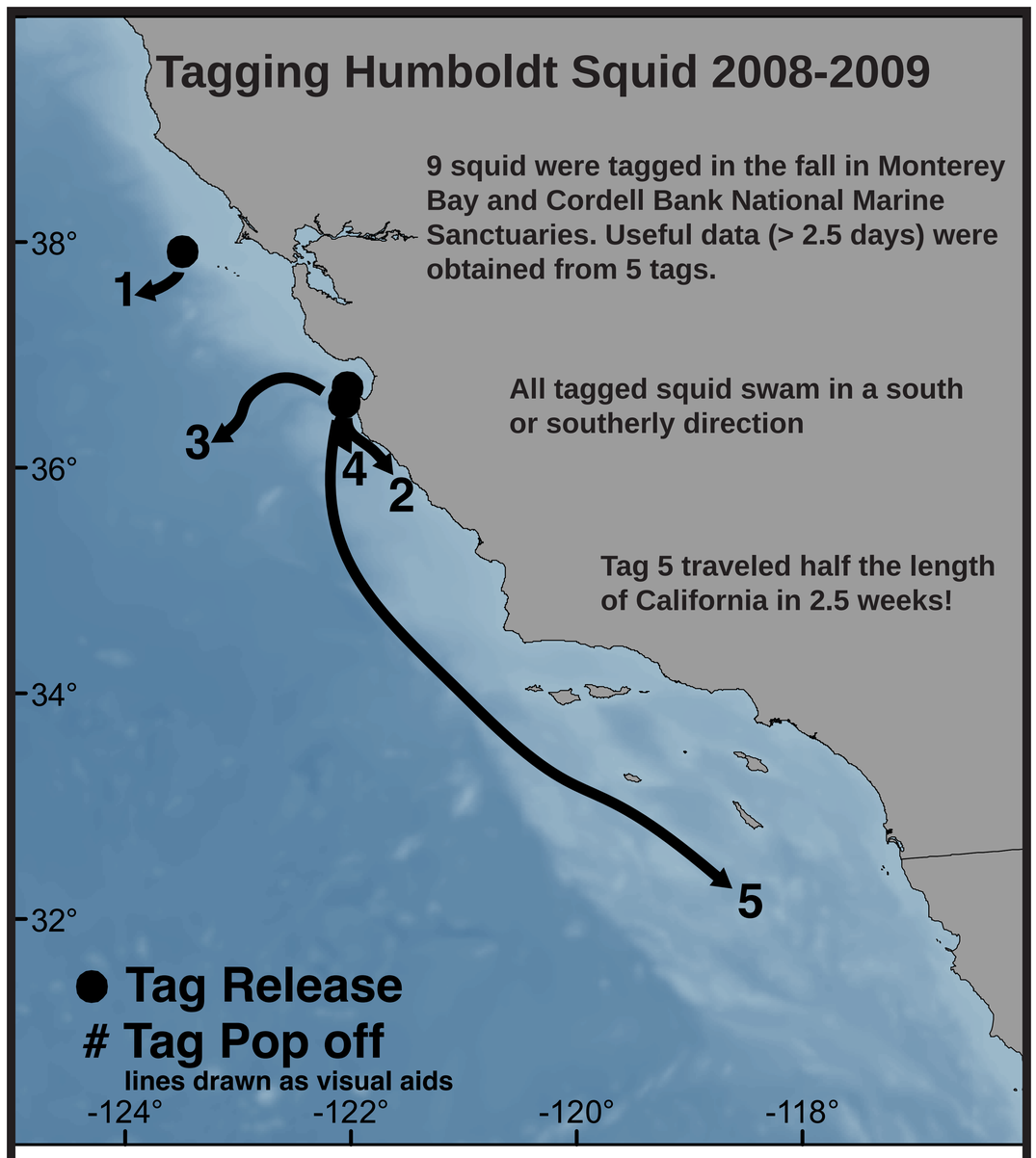
Here we report data from the first Humboldt squid tagged in California waters. Our work aims to identify Humboldt squid behaviors in relation to various physical features, as well as to determine their diet and impacts on ecosystems and fisheries. Tagging Humboldt squid in California follows previous tagging studies in Mexico (Gilly *et al*. 2006; Bazzino *et al*. 2010) and provides new information on diving behavior and habitat use.

Daily Vertical Migrations Displayed by Tag 5



Characteristic behavior involves midwater depths until dusk and shallower depths until dawn

Tagging Humboldt Squid 2008-2009



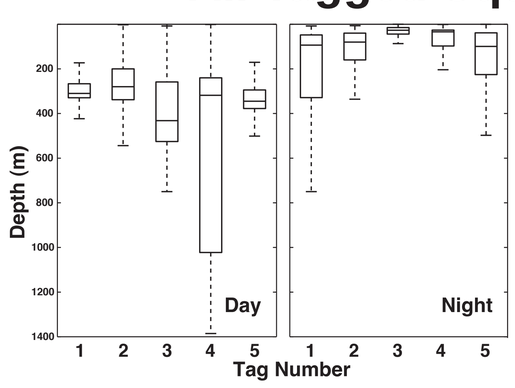
Tag #	sampling time (days)	min. dist. traveled (km)	minimum rate (km/day)
1	2.7	54	20
2	13	108	6.35
3	7	118	21
4	3	45	15
5	17.5	595	35

Tag 5 traveled at least 595 km in 17.5 days: a minimum average velocity of 35 km/day.

Humboldt squid swimming veolcities of > 30 km/day have been observed in Mexico, but Tag 5 provides the first evidence of such speeds sustained for > 3 days.

This behavior is consistent with a fall/winter migration to spawn in warmer waters.

All Tagged Squid Made Daily Vertical Migrations



Daytime medians ranged from 280-432 m (overall median = 310 m)
Nighttime medians ranged from 27-100 m (overall median = 90 m)

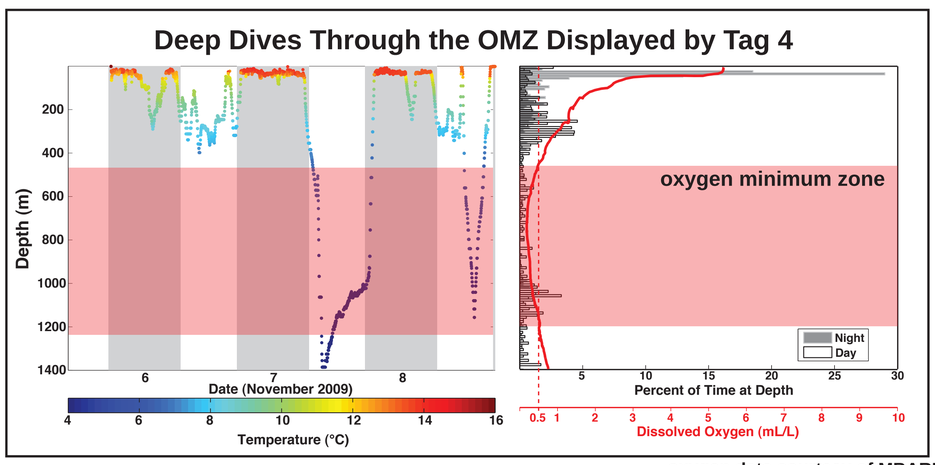
Squid spent 47-83% of nighttime hours at depths < 100 meters. Occupation of such shallow depths in Mexico is only seen in wintertime, when surface temperatures are cooler (Gilly *et al*. in prep).

Humboldt Squid Spend Time in the Oxygen Minimum Zone

The oxygen minimum zone (OMZ) is a midwater environment where dissolved oxygen concentrations drop below 0.5 mL/L (~20 µmol/kg), which is beyond the physiological scope of many marine organisms (Childress 1995).

Deep dives through the OMZ to ~1400 m were observed in two of the five tagged squid. Tag 4 spent 28.3% of the daytime in the OMZ.

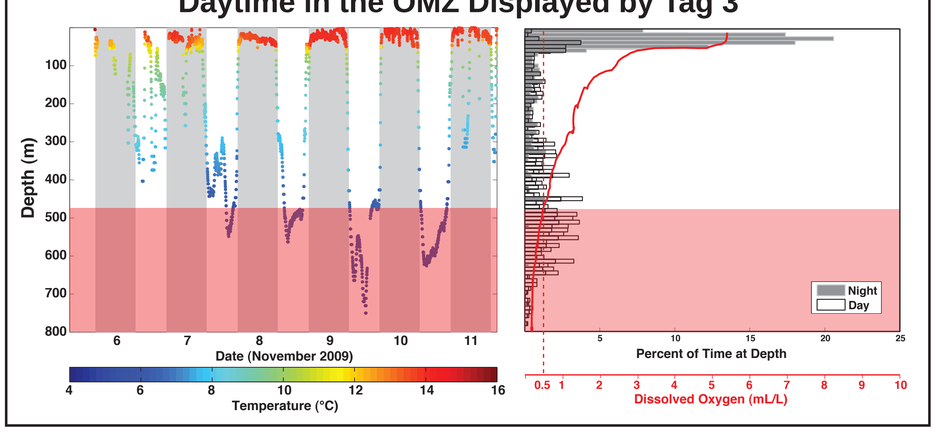
Deep Dives Through the OMZ Displayed by Tag 4



oxygen data courtesy of MBARI

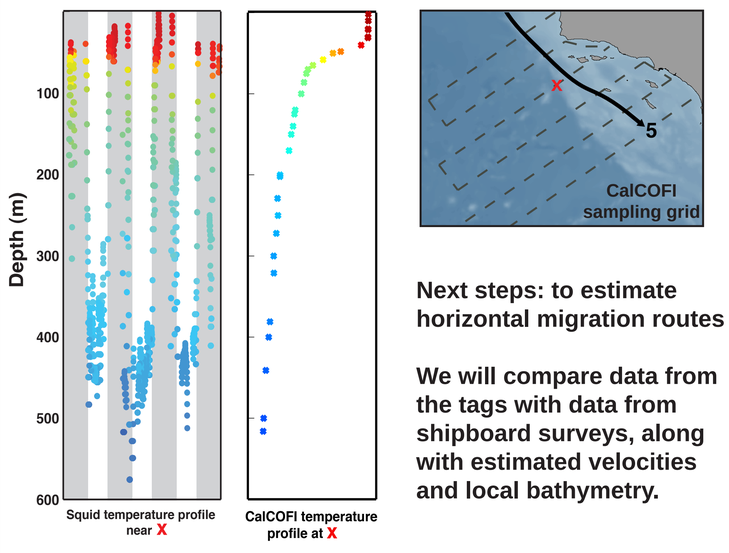
Three tags spent portions of the daytime in the OMZ as part of their characteristic vertical migration, without making deep dives. Tag 3 spent 44.3% of the daytime in the OMZ.

Daytime in the OMZ Displayed by Tag 3



OMZs in California are shoaling, perhaps facilitating the range expansion of Humboldt squid (Bograd *et al*. 2008).

Investigating Horizontal Migrations



Next steps: to estimate horizontal migration routes

We will compare data from the tags with data from shipboard surveys, along with estimated velocities and local bathymetry.

with D. Foley and S. Bograd, NOAA Pacific Grove

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